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The present study examined fixed interval reinforcement of a situational response in a shuttlebox for pigeons. In Experiment 1 the response, being in the responding color, was reinforced on an FI schedule and compared with behavior generated by a fixed time schedule. For the FI schedules reinforcement did not interrupt responding, and the bird began the interval in the responding color. The pause-respond pattern of behavior typically observed with fixed interval schedules of reinforcement was not observed, and the birds tended to remain in the responding color throughout the interval. The manipulations in Experiment 2 were designed to evaluate the importance of several features inherent in a discrete response schedule for generating FI schedule control in more general situations. Two modified situational responses and a discrete shuttle response were reinforced on FI schedules. Pause-respond patterning was observed for each of the schedules, and no significant difference was noted between the schedules when the proportion of the total responding was plotted for successive

quarters of the fixed interval. A common feature of each of the schedules studied in Experiment 2 was the provision that reinforcement interrupt responding and the requirement that the birds initiate responding in every interval. Thus, typical fixed interval performance can be observed with a situational response, but only when certain restrictions, not included in the definition of FI schedules, are imposed.

FIXED INTERVAL REINFORCEMENT FOR A SITUATIONAL RESPONSE

by

Anna Dixon Hatten

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in Partial Fulfillment
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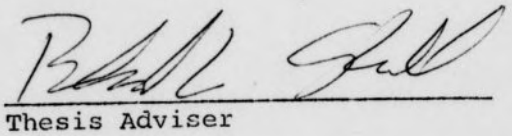
Master of Arts

Greensboro
1974

Approved by



Thesis Adviser

APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

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Committee Members _____

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May 31, 1974
Date of Acceptance by Committee

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CHAPTER 1

EXPERIMENT ONE

Behavior patterns engendered by schedules of reinforcement have been described two ways, in terms of rates of discrete responses and in terms of periods of responding where responding is viewed as a continuous activity. The latter view may be seen as a more general measure. For example, responses which may not be readily counted may be quantified in terms of durations and the durations of periods of responding for different responses may be compared directly when comparisons using frequency measures would be inappropriate. Thus, the view of behavior as periods of responding rather than as a series or instantaneous events may be applied to a wider variety of situations. Most lawful relations found with schedules of reinforcement have been discovered using rate measures. If duration measures are to be a useful substitute, similar lawful relations must be discovered at this level. Relations between independent variables and duration measures should

be evident if, as Gilbert (1958) proposes, responding occurs in bursts with uniform intraburst rates. Under these circumstances any variability observed with the rate measure would be due to changes in the durations of bursts of responding and interburst time, and the view of responding as durations of continuous activity becomes very attractive.

Some data support Gilbert's suggestion. Blough (1963) and Shaub (1967) have presented evidence that rates within response runs are uniform. Measuring interresponse times (IRT's), they found that the modal IRT for key pecking remains between 0.3 and 0.5 sec for different simple schedules and for discrimination learning and generalization testing in extinction. Both experimenters found that the variables manipulated affected mainly the distribution of the longer IRT's. Thus, rate changes typically observed seem to result from changes in the durations of bursts of responding and pausing. Catania (1961) has presented additional evidence that burst rates may be uniform. With concurrent schedules he found that the response rate within runs of responding on a schedule were constant and that only the durations of the pauses varied.

Other evidence supports the notion that duration measures will yield lawful relations similar to rate measures.

Typically it has been found that the relative rate of responding on two schedules programmed concurrently covaries with the relative rate of reinforcement provided by each schedule. Brownstein and Pliskoff (1968) and Baum and Rachlin (1969) have demonstrated a similar covariance between the relative time allocated to one of the schedules and the relative rate of reinforcement provided by the schedules even when the responses were standing in the presence of a color and standing in a particular location respectively. In an extension of these findings Bauman (1972) found that the relative time allocated to a schedule covaried with the relative rate of reinforcement provided by the schedule for concurrent schedules with asymmetrical response requirements. Thus, duration measures, at least in the context of concurrent schedules, are sensitive to reinforcement parameters even in situations where rate measures are inappropriate.

When responding is viewed as a series of instantaneous events, fixed-interval (FI) schedule performance is described in terms of an increasing rate of responding through the interval (Ferster and Skinner, 1957; Dews, 1969). When responding is viewed as continuous, FI performance after

extended training is described in terms of two components: a post-reinforcement interval in which the measured response does not occur followed by a period of responding until the next reinforcer is delivered (Schneider, 1969). Investigators working with the latter level of description have shown that the pause is an increasing function of the duration of the interval (Sherman, 1959; Schneider, 1969; Harzem, 1969; Innis and Staddon, 1971; Shull, 1971), and that the rate of responding and pause duration can be manipulated independently (Farmer and Schoenfeld, 1964; Neuringer and Schneider, 1968; Killeen, 1969; Shull, 1971; Shull, Guilkey, and Witty, 1972). In view of these findings Shull, Guilkey, and Witty (1972) have proposed that FI performance be viewed as two behavioral states with one set of factors determining how the animal allocates its time between responding and pausing and another set determining the behavior that occurs in the response state.

Given that FI performance may be viewed as two behavioral states, it seems likely that the same pause-respond pattern of behavior would occur when the behavior which constitutes the responding state is defined as a continuous response such that food would be delivered whenever the animal is engaged in responding after the interval

has timed out. The pause state would be defined as time not engaged in the response which is reinforced. A simple case may be a situational response where reinforcement is contingent on standing in a particular area of the experimental chamber, and where pausing or not responding would be standing in any other area of the chamber. As mentioned earlier, Baum and Rachlin (1969), using situational responses reinforced on concurrent schedules, found a direct relationship between the relative time spent in one area and the relative rate of reinforcement provided in that area, a relationship similar to that found with rates of discrete responses. The response described is also similar to a situation reported by Neuringer (1973) where key pecks produced fixed periods of time in which reinforcement was independent of responding. These periods are analogous to a response state since reinforcement was contingent upon being in the situation which produced the "free-food" period. Using this type of situational response Neuringer found schedule control for FI and VI schedules. That is, the birds spent more time in the "free-food" period as the interfood interval elapsed for the FI schedule. For the VI schedule the time in the "free-food" was less related to

time since the last reinforcer. It thus appears that situational responses may be expected to be controlled analogously to discrete responses.

The present experiment employed an FI schedule with a situational response which is formally analogous to FI schedules with discrete responses such as the key peck. The schedule differed from Neuringer's procedure in that the responding situation did not depend on key pecking and in that the duration of time in the responding situation was not fixed. That is, the birds' behavior determined the duration of responding. The concern was to see if responding increased as the fixed interval elapsed.

Since schedule control was not observed with these schedules, additional manipulations were performed in a second experiment. The purpose of Experiment 2 was to find sufficient conditions for generating FI schedule control in the context of the shuttlebox.

METHOD

Subjects

Three pigeons, maintained at approximately 80 per cent of their free-feeding weight served as subjects.

Apparatus

The experimental chamber, shown in Fig. 1, consisted of a rectangular chamber 52 cm long, 40.6 cm wide, and 38.5 cm high enclosed in a wooden box. On the front wall two AC light fixtures were mounted, one on each side of the chamber, 32 cm from the floor and 4 cm from the side walls. Red or white bulbs were placed in these fixtures at all times. Below and centered between the lights on the same wall a 6.2 by 5 cm opening was cut 11.3 cm above the floor. A standard solenoid grain feeder was mounted on the wall behind the opening.

The floor of the chamber consisted of three pieces of masonite, a 18 by 52 cm piece and two 9 by 52 cm pieces. The larger piece was mounted lengthwise in the center of the box. On either side of this stationary floor the two smaller pieces were hinged. Springs of sufficient tension to hold the hinged floor level were used to support the movable floor strips. One microswitch was mounted beneath each of the side floor strips such that the weight of the bird standing on the floor would close the switch. Electromechanical equipment was used to program events and to collect the data.

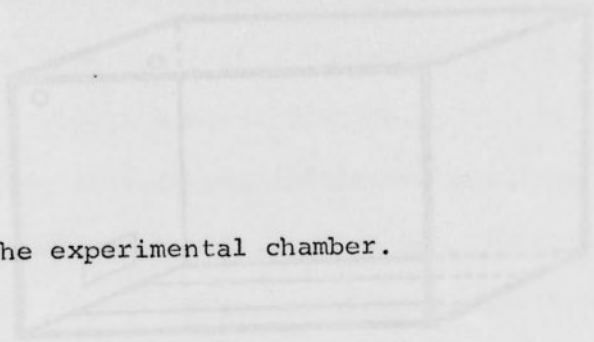
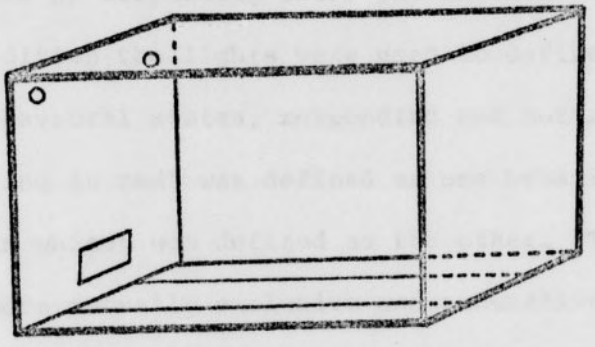


Figure 1. The experimental chamber.



Procedure

The schedule was a fixed-interval with situational responses which was formally analogous to FI's with discrete responses. That is, with the situational response, as well as with the discrete response, reinforcement depended on the first instance of responding after the interval had elapsed. For each condition the lights were used to define two different behavioral states, responding and not responding. That is, "being in red" was defined as one behavioral state, and "being in white" was defined as the other. These situations were mutually exclusive and exhaustive. Responding for the situational response was defined as standing in the presence of one of the two colors. The bird could change the color lighted at any time by moving to the appropriate side of the box. When the bird was standing on the middle strip, the current color lighted depended on which side of the box the bird had stood on just before moving to the center. As long as the responding color was lighted the bird could stay on the middle floor strip and still obtain a reinforcer. If the bird did turn off the responding color, however, it had to move to the side of the box lighting the responding color before it could receive a reinforcer. Thus,

standing on the middle floor strip when the not responding color was lighted was never reinforced. Since responding was just being in the presence of a color, reinforcement did not interupt responding, and the animal began the interval in the presence of the responding color.

To be sure that the behavior observed was not specific to the choice of side or color associated with responding, each side and each color was associated with responding for at least one condition. For condition one, white was the responding color and the right side floor strip controlled initiation of the responding color. For condition two, white was the responding color, and the left side floor strip controlled initiation of responding. For the third phase of the experiment, red was the responding color, and the right side floor strip controlled the initiation of responding. These three conditions were reinforced on an FI 1 min schedule.

In order to assess the effect of the response contingency two of the birds, DE-1 and DA-1, were also reinforced on an FT 2 min schedule where grain was presented at the end of 2 min regardless of which color was lighted. At the termination of reinforcement, however, the red color was

always lighted. Thus, the main difference between this schedule and the FI schedules with the situational response was the contingency for food. For this schedule also, the bird could change the color lighted at any time by moving to the appropriate side floor. Red was controlled on the right and white was controlled on the left. This condition was run after the conditions in Experiment 2.

For all conditions reinforcers consisted of 4 sec access to grain. The daily sessions lasted until 40 reinforcers had been obtained. Table one presents the number of sessions for each condition in both Experiment 1 and 2 and the order in which they were run.

RESULTS AND DISCUSSION

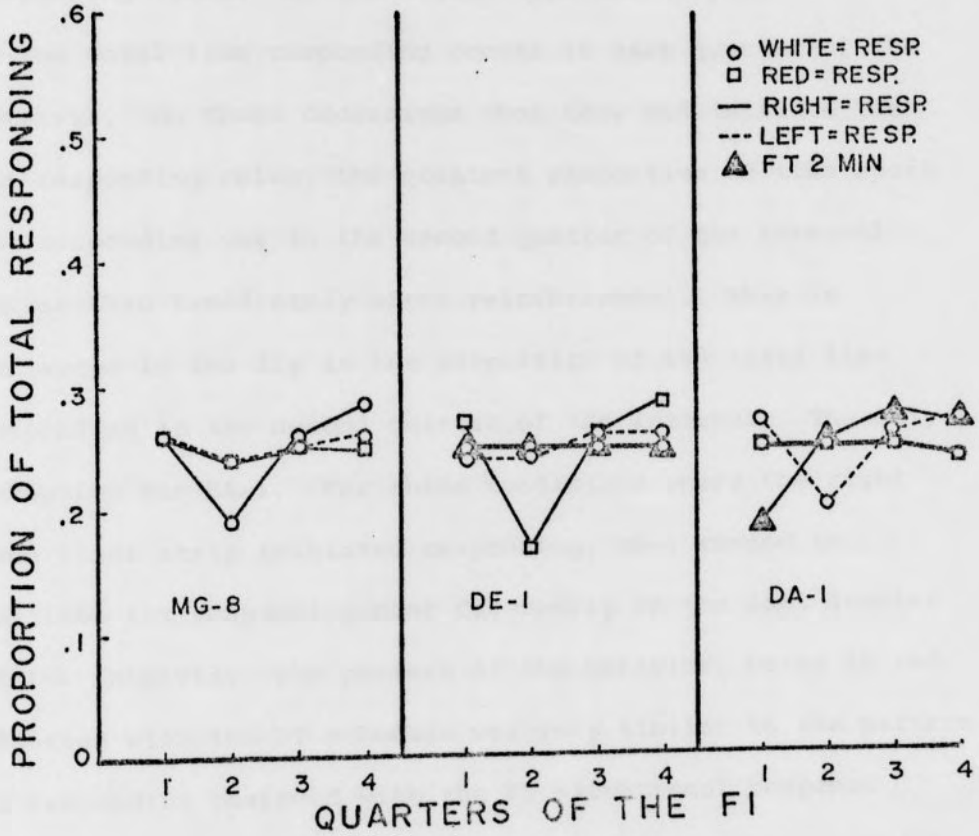
For FI schedules with discrete responses average response frequency increases as time elapses in the interval. Analogous performance with situational responses would consist of increasing average time spent in the responding situation as the interval elapses. Fig. 2 presents the proportion of the total time spent responding in successive quarters of the interval for the situational response conditions in Experiment 1 and the proportion of the total time spent in red for the FT 2 min schedule. For

TABLE 1

EXPERIMENTAL CONDITIONS

CONDITION	ORDER	# SESSIONS MG-8, DE-1, DA-1		
EXPERIMENT ONE				
No response initiation required				
White, right	1	42	92	96
White, left	2	51	51	54
Red, right	3	78	86	93
No response requirement				
FT 2 min	10	15	15	15
EXPERIMENT TWO				
Response initiation required				
Situational, large area				
FI 1 min	4	35	35	35
FI 2 min	9	0	25	36
Situational, small area				
FI 1 min	5	28	31	33
FI 2 min	8	0	42	32
Discrete				
FI 1 min	6	25	25	25
FI 2 min	7	0	31	32

Figure 2. The proportion of the total time spent in the responding color for successive quarters of the FI. The circles represent the conditions where white was the responding color, and the squares represent the conditions where red was the responding color. The solid lines represent the conditions where the right side floor strip controlled response initiation, and the dashed lines represent those conditions where the left side floor strip controlled response initiation. The triangles represent the proportion of the total time in red across successive quarters of the interval for the fixed time 2 min schedule. Each curve is an average of the last five days of the condition.


PROPORTION OF TOTAL RESPONDING
.6
.5
.4
.3
.2
.1
0
WHITE= RESP.
RED= RESP.
RIGHT= RESP.
LEFT= RESP.
FT 2 MIN
MG-8
DE-1
DA-1
1 2 3 4 1 2 3 4 1 2 3 4
QUARTERS OF THE FI

the FI schedules the birds tended to stay in the responding color throughout the interval without changing into the not-responding color. In the figure approximately one-forth of the total time responding occurs in each quarter of the interval. On those occassions when they did initiate the not-responding color, the greatest proportion of time spent not responding was in the second quarter of the interval rather than immediately after reinforcement. This is reflected in the dip in the proportion of the total time responding in the second quarter of the interval. The only exception was DA-1. For those conditions where the right side floor strip initiated responding, DA-1 tended to initiate not responding most frequently in the last quarter of the interval. The pattern of the behavior, being in red, observed with the FT schedule was very similar to the pattern of responding observed with the FI situational response schedules. This suggests that the response contingency did not play an important role in determining the FI behavior.

Several interpretations of these results are possible. One is that the pause-respond pattern of behavior is specific to FI's with discrete responses. This seems unlikely in view of the parallels observed between discrete

and situational responses in other situations (Baum and Rachlin, 1969; Neuringer, 1973). The failure to demonstrate FI response patterning with the continuous situational response does seem to weaken, however, the appeal of duration measures. If reinforcement is actually having its effect at the level of continuous activity rather than individual responses, then the continuous behavior of being in a color should have been controlled by the schedule.

An alternative explanation is that the measured response did not reflect the functional pause-respond states. Skinner (1935) noted that the response class may be defined too broadly or too narrowly to find consistent relationships between variables. Since responding in the present experiment was measured throughout the interval, this would suggest that FI schedule control could have been observed if some subset of topographies included in the responses, standing in the responding color, was measured. This view relates to Staddon and Simmelhag's (1971) more recent account of the Law of Effect. They suggest that the Law of Effect is actually a product of two processes, the Principles of Variation and the Principle of Selection. Any situation produces behavior according to the

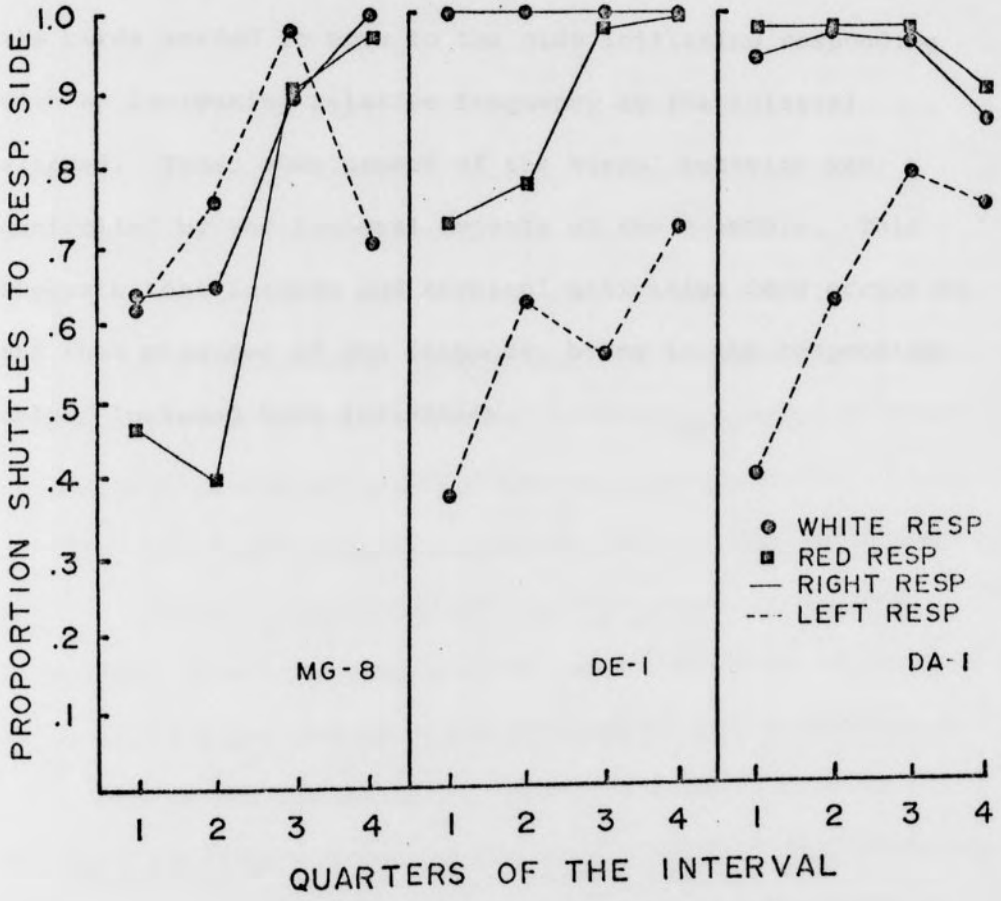
Principles of Variation. When reinforcers are presented intermittently, they noted, behavior is generated according to these principles which can be classified into two types of activities, interim activities occurring when the probability of reinforcement is low and terminal activities occurring when the probability of reinforcement is high or at times proximal to reinforcement delivery. On schedules of food delivery where the interfood interval is constant, the interim and terminal activities temporally correspond to the pause and respond states respectively observed with FI schedules. The same two classes of activities occur, however, even when reinforcement does not depend on a particular response (eg. a fixed-time schedule). When reinforcement does depend on a particular response the Principle of Selection acts on the behavior generated by the Principles of Variation so that the terminal activity is compatible with the requirements for reinforcement.

According to Staddon and Simmelhag's (1971) view, the necessary conditions for observing interim and terminal activities were present in the shuttlebox. Since time spent in the responding color was approximately constant throughout the interval, this account suggests that both interim

and terminal activities were being measured as responding. If interim and terminal activities were occurring in the shuttlebox, then some aspects of the bird's behavior, corresponding with the terminal activity, should occur with increasing probability as the interval elapses. Fig. 3 presents evidence for this type of temporal control. In the shuttlebox differential reinforcement was provided for standing on the responding side floor strip and the center floor strip as well as for being in the responding color. Stepping on the floor strip initiating the not responding color was never reinforced. If spatial aspects of the bird's behavior corresponded with interim and terminal activities, then the bird should have spent more time in areas where reinforcement was more probable as the interval elapsed.

Fig. 3 presents the proportion of the total shuttles from the center to the side floor strip initiating responding across successive quarters of the FI for the situational response FI conditions. A high proportion of shuttles to the side strip initiating responding would suggest that the bird is remaining in areas where reinforcement is more probable. A shuttle was counted whenever the bird stepped

Figure 3. The proportion of the total shuttles to the responding side floor strip across successive quarters of the FI. The circles represent those conditions where white was the responding color, and the squares represent those conditions where red was the responding color. The solid lines represent those conditions where the right side floor strip controlled response initiation, and the dashed lines represent those conditions where the left side floor strip controlled response initiation. Each curve presents the average of the last five days of the condition.


PROPORTION SHUTTLES TO RESP. SIDE
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
MG-8
DE-1
DA-1
WHITE RESP
RED RESP
RIGHT RESP
LEFT RESP
1 2 3 4 1 2 3 4 1 2 3 4
QUARTERS OF THE INTERVAL

from the center to either of the side floors. Although pacing from the center to one side repeatedly did not affect the color lighted, each step onto the side floor counted as a shuttle. In general the figure indicates that the birds tended to move to the side initiating responding with an increasing relative frequency as the interval elapsed. Thus, some aspect of the birds' behavior was controlled by the temporal aspects of the schedule. This suggests that interim and terminal activities were occurring and that measures of the response, being in the responding color, included both activities.

CHAPTER II

EXPERIMENT TWO

When reinforcement was scheduled for the situational response described in Experiment 1, the birds responded constantly throughout the interval, and temporal control over responding never developed. One possible inference from this result is that temporal control over the response develops only when reinforcement is scheduled for discrete responses. Neuringer (1973), however, has presented evidence that at least some form of a situational response will be controlled by FI schedules. It seems, therefore, that there is some property of FI schedules which is important for generating temporal control over responding, but which is not a part of the definition of FI schedules. Since FI schedule control is observed with discrete responses, one strategy for identifying this critical property of the schedule is to compare a typical discrete response schedule with the situational response schedules described in Experiment 1.

One difference is that with discrete response schedules the presentation of the reinforcer interrupts responding, and the bird is required to initiate responding in each interval. With the situational response schedules in Experiment 1, the presentation of the reinforcer did not interrupt responding since responding was merely standing in a color. Thus, the responding color was lighted when the interval began, and the bird did not have to initiate responding in each interval. A sufficient condition for generating FI schedule control may be the interruption of responding by reinforcement and the subsequent requirement that the bird actively initiate responding in every interval.

With discrete responses also the animal generally is required to remain in a relatively small area of the box in order to execute the response. This was not the case with the situational response reported in Experiment 1. For the situational response schedules the bird could move around in approximately two-thirds of the box without turning off the responding color. This suggests that decreasing the size of the area in which the animal may move in the responding color may be important.

The present experiment was conducted to determine to what extent either of the preceding manipulations might be a sufficient condition for generating FI schedule control.

METHOD

Subjects

The subjects of Experiment 1 served.

Apparatus

The experimental chamber was the same shuttlebox described in Experiment 1. Events were programmed and data were collected by electromechanical programming equipment.

Procedure

Two modified situational responses and a discrete shuttle response in the shuttlebox were reinforced on an FI schedule. The discrete shuttle response was included to demonstrate FI schedule control over an experimenter defined response in the shuttlebox. For this response, the responding color flashed briefly whenever the bird stepped on the right floor strip. Continuous standing on the strip was not reinforced and produced only one flash. The two situational responses were defined so that reinforcement interrupted responding, and the bird had to reinitiate responding in every interval. The first of these situational

responses was different from the situational response described in Experiment 1 only in that reinforcement switched off the responding color and turned on the not responding color at the beginning of the next interval. Thus, reinforcement interrupted responding, and the bird had to actively move to reinstate responding in each interval by stepping on the right floor strip. For the second situational response, the responding color was lighted only while the bird stood on the right floor strip. The floor area was smaller for this response, and the bird actively had to stop responding to eat, since the hopper was located in the center of the box. In these respects, this situational response was somewhat more similar to the discrete response than the other situational responses described.

For all of the birds each of the responses described were reinforced with an FI 1 min schedule. Since post-reinforcement pause duration has been found to vary with interval duration when key pecks are reinforced on FI schedules, the interval duration for DA-1 and DE-1 was changed to 2 min.

The reinforcers were 4 sec access to grain. The daily sessions lasted until 40 reinforcers had been obtained. Each condition was studied for at least 25 days.

RESULTS AND DISCUSSION

The concern was to determine what restrictions on responding on FI schedules were necessary for generating FI response patterning. In Experiment 1 reinforcement did not interrupt responding, and the bird could move in a large area without changing into the not responding color. For these schedules time spent responding was approximately constant throughout the interval, and the behavior generated by the schedule did not differ significantly from behavior generated by a fixed time schedule where food delivery was independent of the bird's behavior.

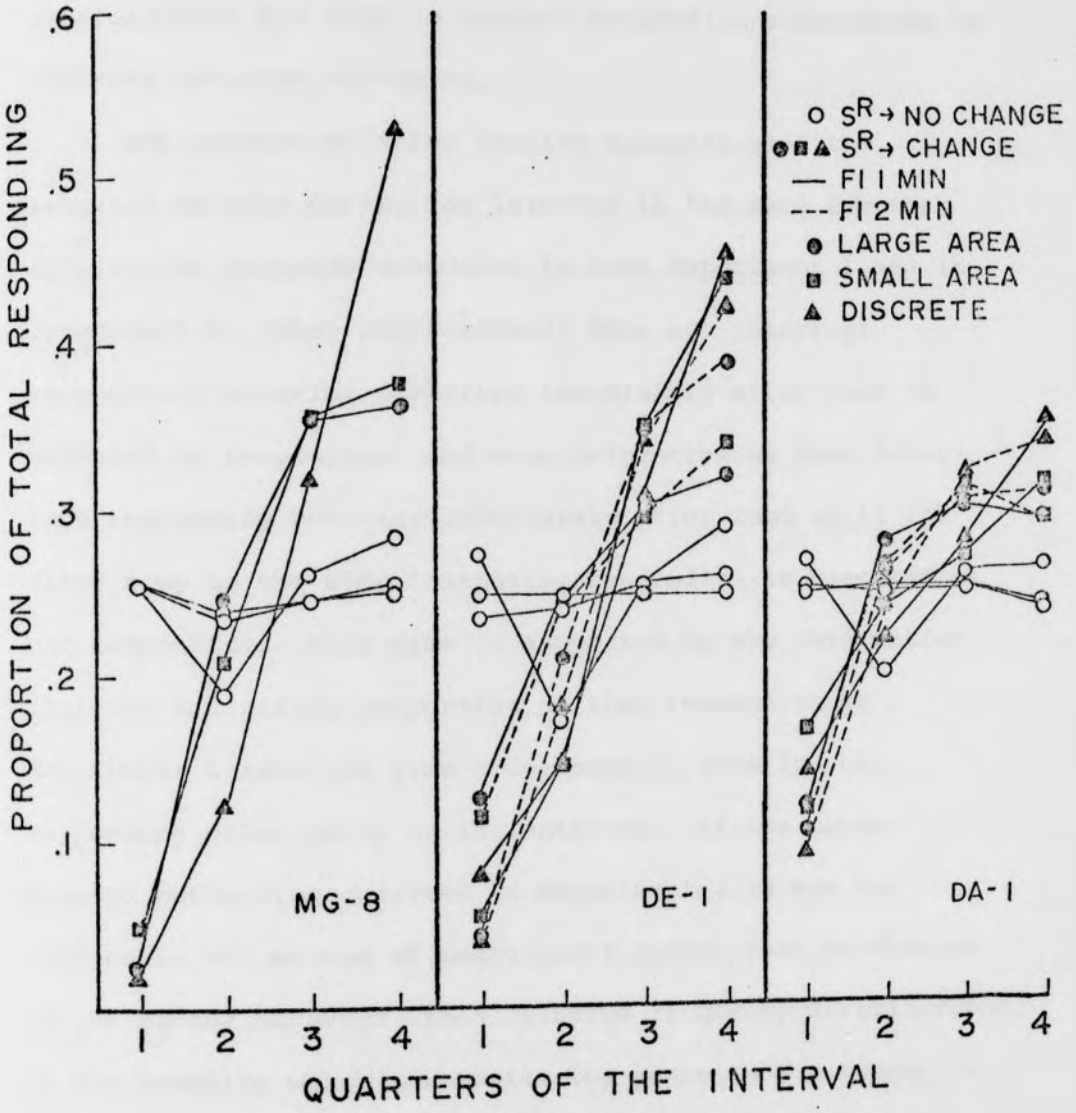
In Experiment 2 several modifications of responding in the shuttlebox were studied. Fig. 4 presents the proportion of the total responding for successive quarters of the FI for these schedules and for the FI 1 min schedules in Experiment 1. To demonstrate FI schedule control over responding in the shuttlebox, reinforcement was scheduled for a discrete response, stepping onto the right floor strip. In the figure this discrete shuttle schedule is represented by the triangles. For this schedule the proportion of the total responding increased as the interval elapsed, and pause-respond patterning was observed. With

key pecking birds typically pause on the average for one-half of the interval. For these birds the pauses for the discrete shuttle response were shorter. For example, on the average MG-8 paused for 37 per cent of the interval, DE-1 paused for 22 per cent of the interval and DA-1 paused for 5 per cent of the interval. Making the response discrete was, however, a sufficient condition for generating pause-respond patterning. A second response, standing on the right floor strip, was studied. This response was not discrete since the duration of the response depended on the bird's behavior rather than on a pulse former, but it did require that the bird initiate responding and remain in a more restricted area than did the situational response described in Experiment 1. These schedules are represented by the squares. As with the discrete shuttle schedules, the proportion of the total responding increased as the interval elapsed, and the same pause-respond pattern was observed. The discreteness of the response, therefore, is not a necessary condition for FI patterning. Finally reinforcement was scheduled for a response which was continuous and which allowed the bird to move in the same area as the situational response in Experiment 1. The only

difference between this response and the situational response in Experiment 1 was that reinforcement interrupted responding, and the bird was required to reinstate the responding color in every interval. For this schedule, represented by the filled circles, the proportion of the total responding as the interval elapsed, and the pause-respond pattern was observed. Thus, reducing the area of responding is not a necessary condition for generating FI patterning. Increasing responding as the interval elapses does, however, seem to depend on the interruption of responding by reinforcement and the subsequent requirement that the bird initiate responding every interval.

For discrete response FI's the post-reinforcement pause is a constant proportion of the interval duration would not substantially affect measures of relative responding as a function of time in the interval. To further assess schedule control over the schedules studied, the interval duration was increased from an FI 1 min to an FI 2 min schedule for birds DE-1 and DA-1. Fig. 4 indicates that the proportion of the total responding as the interval elapsed did not vary with interval duration for these birds.

Figure 4. The proportion of the total responding across successive quarters of the FI. The open circles represent the FI schedules from Experiment 1, where reinforcement did not interupt responding. The triangles represent the discrete shuttle response schedules, the squares represent the situational response, standing on the right floor strip, and the filled circles represent the situational response most similar to the situational response in Experiment 1. For the schedules represented by the filled circles, however, reinforcement interrupted responding. The solid lines represent FI 1 min schedules, and the dashed lines represent FI 2 min schedules. Each curve represents an average of the last five days of the condition.

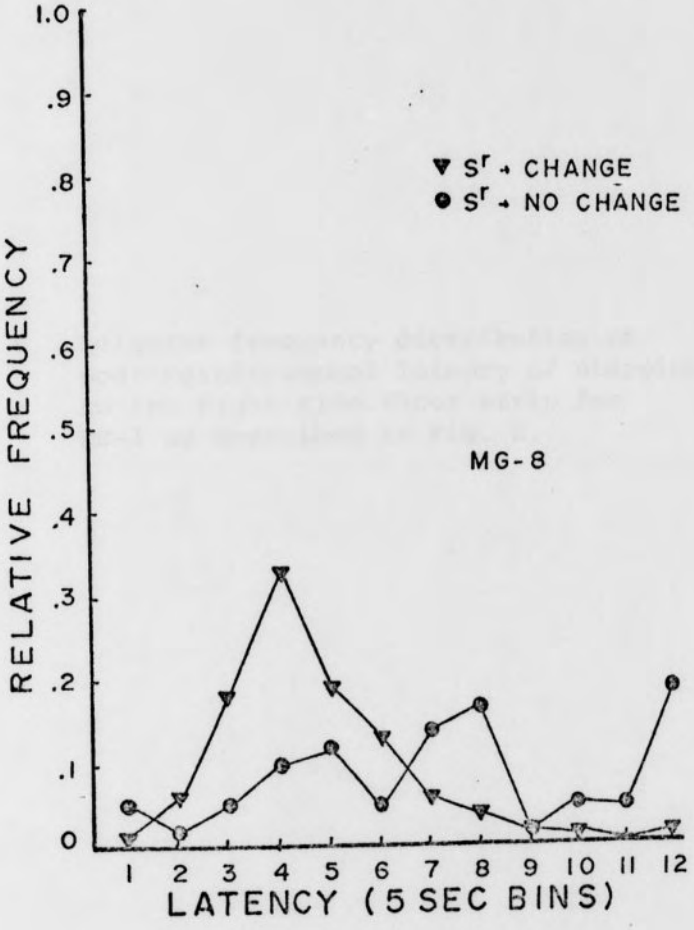

PROPORTION OF TOTAL RESPONDING
.6
.5
.4
.3
.2
.1
MG-8
DE-1
DA-1
1 2 3 4 1 2 3 4 1 2 3 4
QUARTERS OF THE INTERVAL
o $S^R \rightarrow$ NO CHANGE
● ■ ▲ $S^R \rightarrow$ CHANGE
— FI 1 MIN
--- FI 2 MIN
● LARGE AREA
■ SMALL AREA
▲ DISCRETE

Thus, the schedules for which responding was interrupted by reinforcement did seem to control responding analogously to discrete response schedules.

One account of these results suggests that the behavior emitted during the interval is the same for the situational response schedules in both Experiment 1 and in Experiment 2. When reinforcement does not interrupt responding, behavior occurring immediately after food is measured as responding, and when reinforcement does interrupt responding behavior immediately after food until the first step on the side initiating responding is measured as not responding. This view is supported by the observation that the increasing proportion of time responding in Experiment 2 resulted from a decrease in time in the responding color early in the interval. If the pause-respond patterning observed in Experiment 2 is due to changes in the method of measurement rather than to changes in the birds' behavior, then relative frequency distributions of the behavior which terminates the pause in Experiment 2, stepping to the right, should overlap with similar distributions of the same behavior in Experiment 1. That is, the bird should be emitting the behavior, step to the right, with

the same post-reinforcement latency for the situational response schedules in both experiments. In order to make this comparison relative frequency distributions of the post-reinforcement latency of stepping to the right were constructed for two situational response schedules, one where reinforcement did not interrupt responding and one where reinforcement did interrupt responding. Figures 5, 6, and 7 present these data for MG-8, DE-1, and DA-1 respectively. The triangles represent the relative frequency of post-reinforcement latencies of stepping to the right for the situational response, standing in red, where reinforcement interrupted responding. For this schedule the latency of stepping to the right equals the duration of the post-reinforcement pause. The circles represent the relative frequency of post-reinforcement latencies of stepping to the right for the situational response, standing in red, where reinforcement did not interrupt responding. For this schedule stepping to the right had no consequences unless the bird had previously stepped to the left initiating the not responding color earlier in the interval. If only the method of measurement produced the changes in time responding, the relative

Figure 5. Relative frequency distributions of post-reinforcement latency of stepping to the right side floor strip for MG-8. The triangles represent the schedule where reinforcement interrupted responding and the circles represent the schedule where reinforcement did not interrupt responding. Each point was computed from data from the last five days of the condition.


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
RELATIVE FREQUENCY
▼ $S^r \rightarrow$ CHANGE
● $S^r \rightarrow$ NO CHANGE
MG-8
1 2 3 4 5 6 7 8 9 10 11 12
LATENCY (5 SEC BINS)

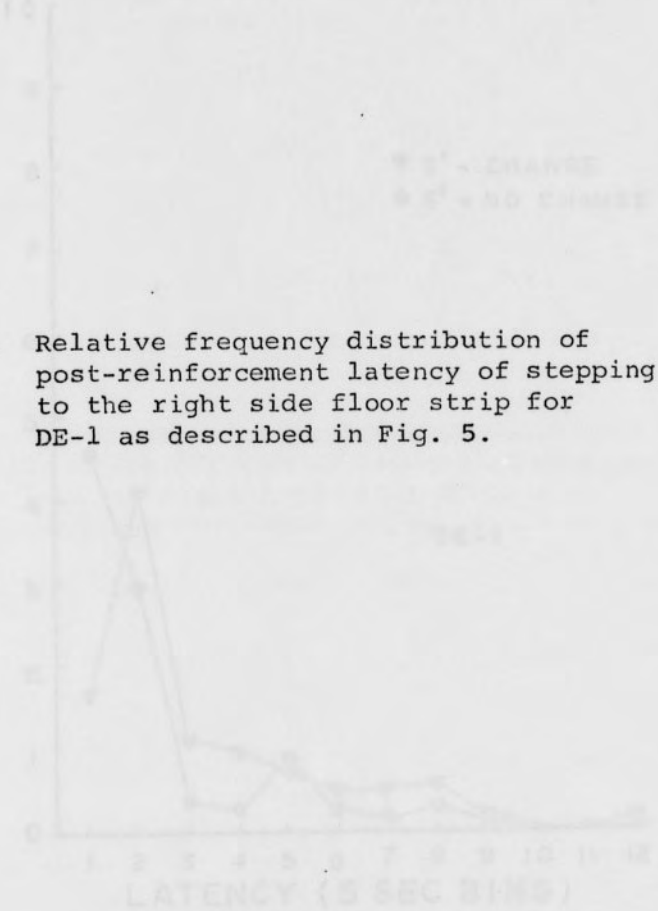
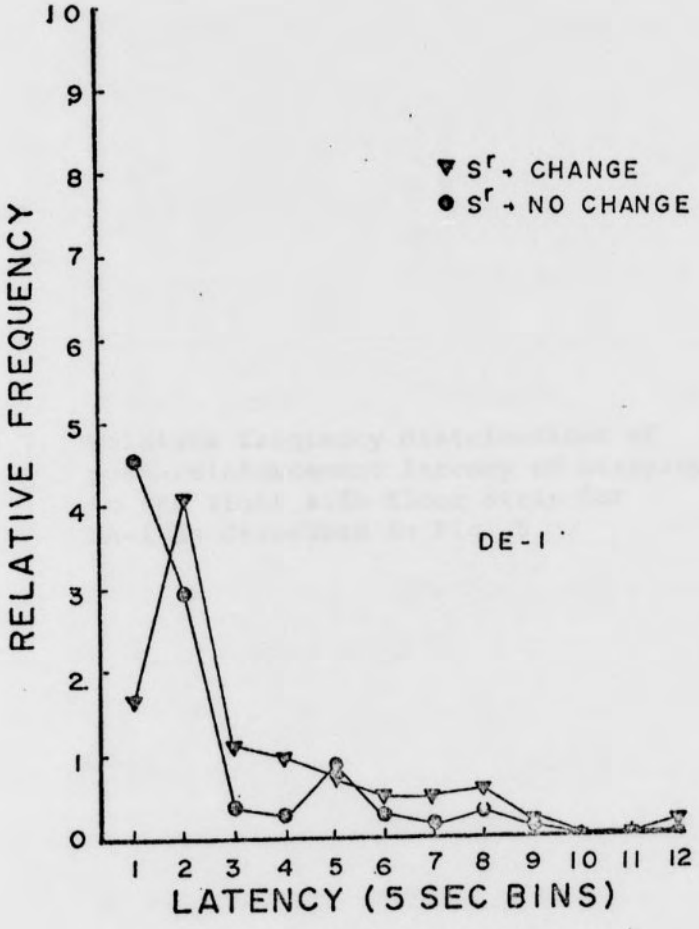


Figure 6. Relative frequency distribution of post-reinforcement latency of stepping to the right side floor strip for DE-1 as described in Fig. 5.


RELATIVE FREQUENCY
0
1
2
3
4
5
6
7
8
9
10
1 2 3 4 5 6 7 8 9 10 11 12
LATENCY (5 SEC BINS)
▽ S^r→ CHANGE
● S^r→ NO CHANGE
DE-I

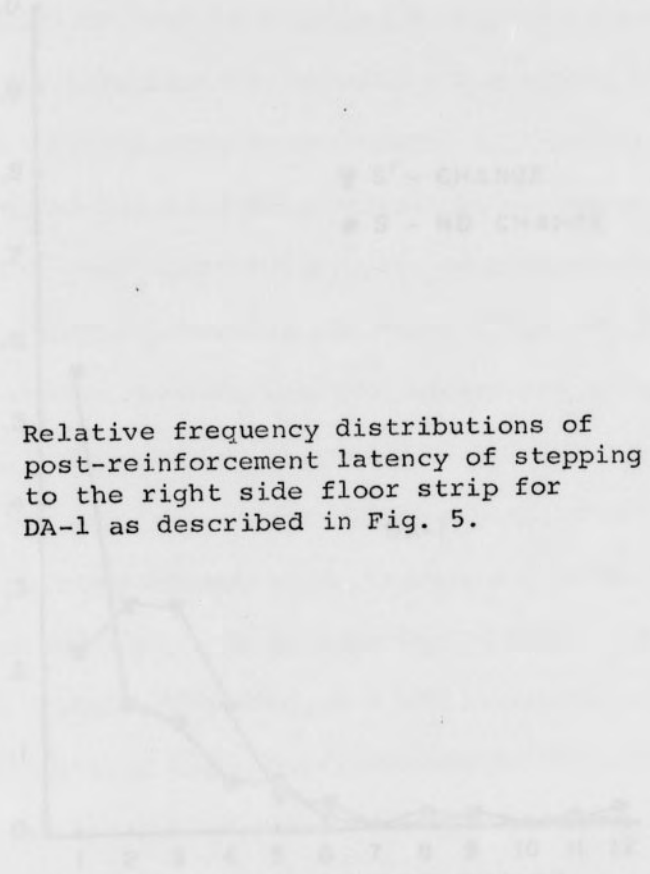
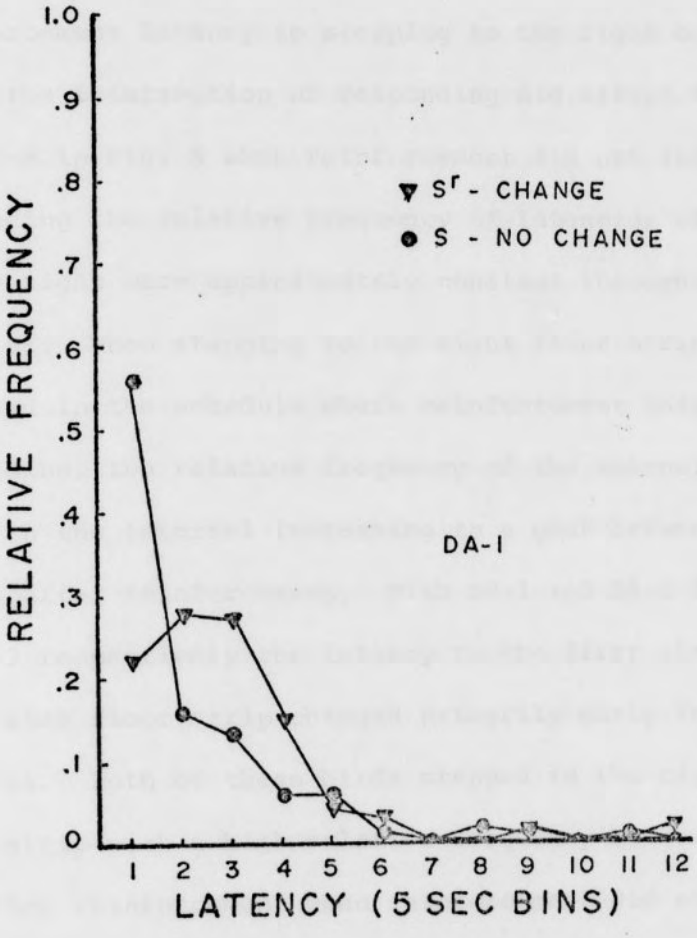


Figure 7. Relative frequency distributions of post-reinforcement latency of stepping to the right side floor strip for DA-1 as described in Fig. 5.


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
RELATIVE FREQUENCY
Sr - CHANGE
S - NO CHANGE
DA-1
1 2 3 4 5 6 7 8 9 10 11 12
LATENCY (5 SEC BINS)

frequency distributions for these schedules should overlap. For each of the birds, however, some change in the post-reinforcement latency to stepping to the right occurred. Thus, the interruption of responding did affect the behavior. For MG-8 in Fig. 5 when reinforcement did not interrupt responding the relative frequency of latencies of stepping to the right were approximately constant throughout the interval. When stepping to the right floor strip was required in the schedule where reinforcement interrupted responding, the relative frequency of the latencies was low early in the interval increasing to a peak between 15 and 20 sec after reinforcement. With DE-1 and DA-1 in figures 6 and 7 respectively the latency to the first step on the right side floor strip changed primarily early in the interval. Both of these birds stepped to the right side floor strip with a high relative frequency between 1 and 5 sec after reinforcement when reinforcement did not interrupt responding. When reinforcement did interrupt responding and stepping on the right side floor strip terminated the post-reinforcement pause, the frequency of these early steps to the right side floor strip decreased. These data indicate that the FI schedule control obtained by interrupting

responding by reinforcement resulted from more than just changing the response criterion for behavior which remained constant. It might be expected that requiring a behavior in every interval for reinforcement would increase the probability of the behavior. In the present study, however, stepping to the right decreased early in the interval for the schedule which required that behavior in every interval. Thus, immediately after food when the relative proximity to reinforcement was lowest, there was a low probability of emitting the behavior which terminated the post-reinforcement pause. This suggests that the schedule developed temporal control over stepping to the right such that the behavior tended to occur only at times more proximal to reinforcement. In the present study schedule control depended on providing a situation where a transition between pausing and responding is required in every interval. These data suggest that temporal control over the transition response is the mechanism by which the increasing average responding as the interval elapses is obtained.

One interesting difference was observed between the schedules in the shuttlebox and key pecking situations.

For each animal the relative post-reinforcement pauses were approximately equal for each of the schedules studied in Experiment 2, and they were generally shorter than pauses typically observed with key peck schedules. Each of these schedules studied in Experiment 2 had the same transition response, move to the right, whereas the transition response between pausing and responding in key peck situations is a key peck. Perhaps the degree of temporal control which occurs is strongly related to the nature of the transition response. That is, some transition responses may tend to occur earlier or later in the interval than others. This suggests that although pause-respond patterning depends mainly on the presence of a transition response, the pause duration may be manipulated by varying the nature of the transition response.

CHAPTER III

GENERAL DISCUSSION

The present experiment was concerned with evaluating the general utility of duration measures as a substitute for measures derived from viewing responding as a series of instantaneous events. If this view of responding is appropriate responses which can not be characterized as discrete instantaneous events should be controlled by schedules of reinforcement analogously to discrete responses. When reinforcement, however, was delivered according to an FI schedule for a situational response, the typical pattern of responding generated by FI schedules did not occur. This suggested either that the discreteness of the response is a necessary condition for obtaining FI schedule control and that the view of responding as durations of continuous responding does not have general applications or that some other property of discrete response schedules is important for obtaining FI schedule control. Discreteness of the response, however, was not a

necessary condition for FI schedule control. Instead, in the present context a sufficient condition was the provision that reinforcement interrupt responding and the requirement that the bird initiate responding in each interval.

One explanation for this result which is supported by the data is that the temporal patterning of responding on FI schedules depends heavily on the development of temporal control over the behavior which initiates the responding state. With key pecking this would be the first peck, terminating the post-reinforcement pause, and with the situational response it would be the behavior which changes the not responding color which is lighted after reinforcement to the responding color. If reinforcement does not interrupt responding, the bird is already in the responding state as the interval begins. If FI response patterning is primarily a result of temporal control over the activity of changing into the responding state then the condition where no change is required would not be expected to show FI patterning of responding.

With discrete responses the bird is not only required to initiate responding in every interval, but also, if the

response which terminates the post-reinforcement pause is not also the reinforced response, the bird must initiate subsequent responses within the interval. The finding that FI schedule control can be developed with a situational response which does not require the animal to continuously reinitiate responding indicates that requiring the additional initiations of response after the first initiation in the interval is unnecessary. This finding is consistent with a view of responding as continuous activity once it has been initiated, but it also suggests that the transitions between one steady state condition, either being in a color or key pecking, to another are the more important data.

If control over responding by the schedule operates at the level of transitions between states, then perhaps other situations may be viewed in terms of transitions, and the variables which determine these transitions should be explored. For example, with concurrent schedules, Baum and Rachlin (1969) explained their results in terms of the covariance of the relative time allocated to a schedule and the relative rate of reinforcement provided by that schedule, a position consistent with the continuous view of responding. An analysis in terms of transitions would suggest that the

variables controlling the changeover response between the two schedules would be the level at which the concurrent schedule controls the behavior. With fixed interval schedules the relative proximity of reinforcement is a good predictor of the probability of a transition between pausing and responding. The same principle may be applied to other situations such as the concurrent schedule described by Baum and Rachlin (1969).

CHAPTER IV

SUMMARY

Typically responding generated by fixed-interval schedules with discrete responses increases as the interval elapses. When reinforcement was scheduled for the situational response, standing in the responding color, where reinforcement did not interrupt responding, the birds remained in the responding situation throughout the interval. FI schedule control was demonstrated, however, for situational response FI schedules when reinforcement did interrupt responding and the birds were required to initiate responding in every interval. The data suggested that FI schedule control depends on the requirement of a transition response which terminates the post-reinforcement pause and initiates responding. It was proposed that the typical FI schedule performance results from the development of temporal control over the transition response.

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